

**STUDY ON THE ISSUES RELATED TO EFFECTIVE
IMPLEMENTATION OF ENERGY SERVICE
COMPANIES IN SRI LANKA AND ITS IMPACT
POTENTIAL TO ENERGY EFFICIENCY**

Welhenage Wikramarathna

(08/8616)



University of Moratuwa, Sri Lanka.
Electronic Theses & Dissertations
www.lib.mrt.ac.lk
Degree of Master of Engineering

Department of Mechanical Engineering

University of Moratuwa

Sri Lanka

September 2013

**STUDY ON THE ISSUES RELATED TO EFFECTIVE
IMPLEMENTATION OF ENERGY SERVICE
COMPANIES IN SRI LANKA AND ITS IMPACT
POTENTIAL TO ENERGY EFFICIENCY**

Welhenage Wikramaratna

(08/8616)



Thesis submitted in partial fulfillment of the requirements for the degree of Master of
Engineering.
University of Moratuwa, Sri Lanka.
Electronic Theses & Dissertations
www.lib.mrt.ac.lk

Department of Mechanical Engineering

University of Moratuwa

Sri Lanka

September 2013

DECLARATION

I certify that this thesis does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any university to the best of my knowledge and belief. It does not contain any material previously published, written or orally communicated by another person or myself except where due reference is made in the text.

Also I hereby grant to University of Moratuwa the non-exclusive right to reproduce and distribute my thesis in whole or part in print, electronic or other medium. I retain the right to use this content in whole or part in future works.



UOM Verified Signature University of Moratuwa, Sri Lanka.
Electronic Theses & Dissertations
v.lib.mrt.ac.lk

30/09/2013

W.H. Wikramaratna

Date

The above candidate has carried out research for the Master of Engineering under my supervision.

UOM Verified Signature

30/09/2013

Signature of the Supervisor

Date

Prof. R. Attalage

ABSTRACT

Energy Service Companies (ESCOs) business started in Sri Lanka more than a decade ago. However, formal registration of ESCOs in Sri Lanka began with the establishment of Sri Lanka Sustainable Energy Authority (SLSEA) which is the successor of the Energy Conservation Fund. Due to various barriers, growth rate of ESCOs found to be very low compared with some ESCOs in the region. This study was undertaken to identify the root causes of this issue, and to understand the likely market for an ESCO business in Sri Lanka.

According to the findings of the study which involved the active ESCOs, industries and commercial sector organizations and energy experts, major barrier for growth in ESCO business is found to be the low level of data collection in industry and commercial sectors related to their energy systems. This is followed by the unfavorable procurement practices and economic uncertainties in the country which are not directly controllable by ESCOs which shall be a consideration for the policy makers of the country. Due to the lack of mutual trust between ESCOs and their customers, Sri Lanka's ESCOs seem to be caught up in a vicious cycle, which leads to reduced revenue growth of this business. In order to break this vicious cycle, strong government support with necessary policy changes is required. Similar initiatives have been taken in China and many more countries in the world. When comparing Sri Lanka's position in energy efficiency and energy conservation relative to the world's most energy efficient economies based on International Energy Score Card, Sri Lanka's situation can be seen as far from satisfactory.

According to the estimations made, for year 2010, amount of tradable energy which is more related to ESCOs revenue, is around 817,000 toe. With a bare minimum saving of 10% and 5% in industrial and commercial sectors respectively, there is US\$50 million (based on 2010 energy prices and exchange rates) potential market for exploitation by an effective ESCO, business. Energy saved by the ESCO business today will have much more value than what is perceived in financial and economic terms when it is seen in a broader perspective of sustainability of the world. Startup ESCOs in a country, if supported by a pool of practical and efficient energy experts who are not entirely dependent on the revenue of ESCOs, will improve the trust between ESCOs' and their customers and it will lead to break the vicious cycle, allowing the ESCO business to exploit the considerable market potential available.

In this context, this study recommends the formation of pilot ESCOs, creation of a guarantee fund and compulsory energy audits for industrial and commercial sectors with sufficient awareness through government support.

ACKNOWLEDGMENT

I express my sincere thanks to Prof. R.A. Attalage, professor of mechanical engineering, University of Moratuwa, my research supervisor, for his guidance and encouragement to enable me to complete this project successfully. I also thank Dr A.G.T. Sugathapala, Course coordinator, MEng/PG Dip in Energy Technology, Department of Mechanical Engineering ,University of Moratuwa for his support during selection of a topic for the research project and onwards.

I am grateful to Mr. M.R. Ranjith , Director Energy Management, Sri Lanka Sustainable Energy Authority for his valuable commitment and kind support delivered to me at every instant required. Also I thanks Mrs. Ushani Epa, executive officer , Sri Lanka Sustainable Energy Authority ,for her dedication to help whenever I requested data from SLSEA to use in my report.

I would like to express my thanks to Mr. A.P. Sampath, Mechanical Engineer, Kelanithissa Power station and most of my batch mates who helped me during the questionnaire survey to get feedback from relevant parties.

The support given by the respondents from ESCOs, industrial and commercial sector is also much appreciated.

Finally I would like to thank my wife and two children for understanding and making my life and work bearable.

W.H.Wikramarathna

CONTENTS

DECLARATION	i
ABSTRACT	ii
ACKNOWLEDGMENT	iii
CONTENTS	iv
LIST OF TABLES	viii
LIST OF FIGURES	x
ABBREVIATIONS	xi
CHAPTER 1: INTRODUCTION	1
1.1. Background	1
1.1.1 General Definition for ESCO	2
1.1.2 Formation of ESCO and current position in the world	3
1.2 Problem Statement	4
1.3 Objectives of the Project	5
1.4 Methodology adopted	5
1.5 Need of effective ESCOs for energy saving	5
CHAPTER 2: PRESENT ENERGY SCENARIO OF SRI LANKA	7
2.1 Energy Generation and Supply in Sri Lanka	7
2.2 Energy Sector Governance	8
2.2.1 Establishment of Energy Conservation Fund	9
2.2.2 Establishment of Sri Lanka Sustainable Energy Authority	10
2.3 Energy Conservation and Energy Efficiency Programs In The Country	10
2.4 Role of ESCO in the Energy Scenario	14
CHAPTER 3: ESCO OPERATION IN WORLDWIDE	16
3.1 Background of World ESCOs	16
3.2 ESCO Operation in USA	16
3.2.1 Formation of ESCOs in USA	16

3.2.2 ESCO Business Model in USA.....	18
3.2.2.1 Shared Saving ESCO Business Model(SSM)	20
3.2.2.2 Guaranteed Saving ESCO Business Model (GSM)	21
3.2.2.3 Other Business Models of ESCOs	22
3.2.3 Market Trend of ESCOs in USA	23
3.2.4 Barriers For ESCO Implementing in Private Sector	24
3.2.4.1 Market Barrier on ESCOs in Private Sector	24
3.2.4.3 Institutional barrier on ESCOs in Private Sector	24
3.2.4.3 Financial Barrier on ESCOs in Private Sector	25
3.3 ESCOs Operation in Europe	25
3.3.1 Background of ESCOs in Europe	25
3.3.2 ESCO Models in Europe.....	27
3.3.3 Market Trend.....	27
3.3.4 Barriers on ESCOs in Europe	29
3.3.5 Potential of Energy Saving Through ESCOs.....	30
3.4 ESCO Activities in Asia.....	31
3.4.1 Background of ESCOs in Asia.....	31
3.4.2 ESCO Models in Asia	31
3.4.2.1 ESCO Financing Models.....	32
3.4.2.2. ESCO Remuneration Models.....	33
3.4.3. Market Size of ESCOs in Asia and Its Trend	33
3.5 Discussion on ESCO Operation in World Wide	45
3.6 Summery of Issues for ESCOs.....	48
CHAPTER 4: STATUS OF ESCOs IN SRI LANKA	50
4.1 Background of EE & EC Activities	50
4.2 Previous Studies on ESCOs in Sri Lanka	50
4.3 ESCOs in Sri Lanka and their Structures.....	51
4.4 Effectiveness of ESCOs	54

CHAPTER 5 : CHARACTERIZING AND IDENTIFYING BARRIERS OF ESCOs IN SRI LANKA.....	55
5.1 Services Carried Out by ESCOs	55
5.2 Summary of Project Carried Out by ESCO and Energy Saving Potential.....	56
5.3 Survey to Identify Issues/Barriers on Sri Lanka ESCOS.....	58
5.3.1 Structure of Survey	58
5.3.2 Structure of Questionnaire for ESCOs.....	58
5.3.2.1 Selection of ESCOs For The Survey.....	58
5.3.3 Structure of Questionnaire for Industry and commercial sector	59
5.3.3.1 Selection of Industries and Commercial Sector for Questionnaire	59
5.3.4 Questionnaire for Energy Experts	60
5.3.4.1 Selection of Energy Expert.	60
5.4 Analysis of Survey Results	62
5.4.1 Methodology	62
5.4.2 Identification of Importance Issues/Barriers	63
5.4.2.1 Rank of Issues Based on ESCOs Feed backs.....	63
5.4.2.3.Rank of Issues Based On Industry and Commercial Sector Feed Back ..	65
5.4.1.1.Rank of Issues Based on Energy Expert Feed Back	69
5.3 Identification of Most Significant Barriers Based on Views of ESCOs, Energy Experts and Industry	71
5.4 ESCO Model In Sri Lanka	75
5.5 ESCO Business Model For Sri Lanka.....	77
5.6 Vicious Cycle faced by Sri Lanka ESCOs	78
CHAPTER 6 : IMPACT POTENTIAL TO SAVE ENERGY WITH EFFECTIVE ESCO	80
6.1 Energy Intensity Of Sri Lanka and Level of EE & EC	80
6.1.1 Introduction.....	80
6.1.2 Methodology	80
6.1.3 Calculation Of Energy Intensity Of Sri Lanka.....	81

6.1.4. Analysis Of Present Level Of Energy Efficiency In Sri Lanka.....	82
6.2 Amount Of Energy Usage By Industry And Commercial Sector In Sri Lanka	86
6.3 Estimation Of Energy Saving Potential Through Effective ESCOs And ESCO Market Potential	88
CHAPTER 7: CONCLUSION AND RECOMMENDATION.....	91
REFERENCES.....	93
APPENDICES.....	95



University of Moratuwa, Sri Lanka.
Electronic Theses & Dissertations
www.lib.mrt.ac.lk

LIST OF TABLES

Table 3.1: ESCO Activity and Market Development in Major EU Countries.....	26
Table 3.2: ESCO Activities in Selected EU Countries	28
Table 3.3: Most Important Barriers in Selected EU Countries	30
Table 3.4: Summery of Issues for ESCOs	48
Table 4.1: List of ESCOs from Year 2008 to Year 2011.....	51
Table 5.1: ESCO Activities Under Three Service Category.....	55
Table 5.2 A: Summary of Activities of ESCOs from Year 2008 to Year 2011.....	56
Table 5.2 B: Summary of Annual Energy Saving Potential and Energy Saving Achieved from Year 2008 to Year 2011	57
Table 5.3: Rating, Abbreviations and Percentage for ESCO Questionnaire.....	63
Table 5.4: Ranking of Issues of ESCOs Based on Questionnaire Feedback	64
Table 5.5: Grouping Of Industry and Commercial Sector for Questionnaire.....	65
Table 5.6: Ranking Issues based on feedback from Industry of Category A.....	66
Table 5.7 : Ranking Issues based on feedback from Industry of Category B.....	66
Table 5.8: Ranking Issues based on feedback from Industry of Category C.....	67
Table 5.9 : Ranking Issues based on feedback from Industry of Category D.....	68
Table 5.10: Ranking of Issues based on feedback from Industry of Category E.....	69
Table 5.11 : Ranking of Issues based on feedback from Energy Experts.....	70
Table 5.12: Summary of Issues and feedback score & Rank of ESCO, Energy Expert and Industry	72
Table 5.13: Summary of Issues of ESCOs from highest to lowest based on Weighted Average of Importance index.....	73
Table 5.14 : Summary of ESCOs registration from 2008 to 2011.....	77
Table 6.1: Calculation of Energy Intensity of Sri Lanka	81
Table 6.2: International Energy Efficiency Scorecard.....	83
Table 6.3: Per Capita Energy consumption and Per Capita GDP for several countries ..	84
Table 6.4 - Energy Consumption in difference Sectors	86

Table 6.5: Petroleum & Biomass Energy Consumption In Household Commercial and others 2010.....	87
Table 6.6 - Commercial Sector Energy consumption estimation for year 2010.....	87
Table 6.7 - Total energy consumption in industry and commercial sector in year 2010.	88
Table 6.8: Total Tradable Energy Consumption in Industrial Sector by Type of Energy	88
Table 6.9: Price of One toe in Rupees for each type of Energy relative to year 2010.....	89
Table 6.10: Tradable Energy consumption In Commercial and Industrial Sector in Million LKR.....	89
Table 6.11: Total Energy Saving potential	90



University of Moratuwa, Sri Lanka.
 Electronic Theses & Dissertations
www.lib.mrt.ac.lk

LIST OF FIGURES

Figure 2.1: Primary Energy Supply	7
Figure 2.2: Energy Demand by Sectors	8
Figure 2.3: Evaluation criteria for NEEA	13
Figure 3.1: Growth of ESCO Industry in USA from 1990 to 2006	17
Figure 3.2 : Cash Flows in a Simplified ESCO project	19
Figure 3.3: ESCO – Client Combination In ESCO Project	19
Figure 3.4: Shared Saving ESCO Business Model (SSM)	20
Figure 3.5: Guaranteed Saving ESCO Business Model (GSM)	21
Figure 3.6: Market Size of ESCOs in Asia and its Trend	34
Figure 3.7: ESCO Performance in Japan	36
Figure 3.8: ESCO Performance in China	38
Figure 3.9: ESCO Performance in Thailand	40
Figure 4.1: Structure of ESCO in Sri Lanka from Year 2008 to Year 2011	54
Figure 4.2: ESCO Service Portfolio for Year 2010	56
Figure 5.1: Flowchart for generation of questionnaire for Industry and commercial sector	61
Figure 5.2: Functions of Full Fledge ESCO.....	76
Figure 5.3 : Vicious Cycle of ESCOs in Sri Lanka	Error! Bookmark not defined.
Figure 6.1: Variation of Energy Intensity of Sri Lanka	82
Figure 6.2: Indication of International Energy Efficiency Scorecard.....	84
Figure 6.3: Per Capita Energy Consumption Vs Per Capita GDP for several Counties ..	85
Figure 6.4 : Energy Demand by Sector 2010.....	86

ABBREVIATIONS

ESCO	Energy Service Company
HVAC	Heat Ventilation and Air Conditioning
ECF	Energy Conservation Fund
EE	Energy Efficiency
EC	Energy Conservation
SLSEA	Sri Lanka Sustainable Authority
CEA	Central Environment Authority
teo	ton of oil equivalent
PUCSL	Public Utilities Commission of Sri Lanka
CFL	Compact Fluorescent Lamp
NEEA	National Energy Efficiency Award
EPC	Energy Performance Contract
EERS	Energy Efficiency Resource Standard
ARRA	American Recovery and Reinvestment Act
SSM	Shared Saving Model
GSM	Guaranteed Saving Model
FI	Finance Institute
TPF	Third Party Financing
CHP	Combine Heat and Power
GHG	Green House Gas
EMS	Energy Management System
SPV	Special Purpose Vehicle
JAESCO	Japanese Association of Energy Service Companies
GEF	Global Environmental Facility
BEE	Bureau of Energy Efficiency